

IN THE CLAIMS:

1. (Currently amended) An apparatus for sending a heartbeat signal in a cluster computing system, the apparatus comprising:
- a first host group; and
 - a first storage system associated with the first host group, the first host group coupled via a network to a second host group, the first storage system coupled via a remote link to a second storage system associated with the second host group, the first host group configured to selectively send a heartbeat signal to the a second host group by use of the ~~a network coupled between the first host group and the second host group or by use of a remote link coupled between the first storage system and a second storage system associated with the second host group.~~
2. (Currently amended) A method of sending a heartbeat signal in a cluster computing system, the method comprising:
- generating a heartbeat signal from a first host group, the first host group being associated with a first storage system;
 - selectively sending the heartbeat signal from the first host group to a second host group ~~by use of a network coupled between the first host group and the second host group or by use of a remote link coupled between the~~ a first storage system associated with the first host group and a second storage system associated with the second host group.
3. (Currently amended) An electronically-readable medium storing a program for permitting a computer to perform method of sending a heartbeat signal in a cluster computing system, the method comprising:
- generating a heartbeat signal from a first host group, the first host group being associated with a first storage system;
 - selectively sending the heartbeat signal from the first host group to a second host group ~~by use of a network coupled between the first host group and the second host group or by use of a remote link coupled between the~~ a first storage system associated with the first host group and a second storage system associated with the second host group.

4. (Currently amended) A program code embedded on a carrier wave for causing a computer to perform a method of sending a heartbeat signal in a cluster computing system, the method comprising:

generating a heartbeat signal from a first host group, the first host group being associated with a first storage system;

selectively sending the heartbeat signal from the first host group to a second host group ~~by use of a network coupled between the first host group and the second host group or by use of a remote link coupled between~~ the ~~a~~ first storage system associated with the first host group and a second storage system associated with the second host group.

5. (Currently amended) An apparatus for receiving a heartbeat signal in a cluster computing system, the apparatus comprising:

a remote host group; and

a remote storage system associated with the remote host group, the remote host group configured to selectively receive a heartbeat signal ~~from a network coupled with the remote host group or by use of a remote link coupled to the remote storage system.~~

6. (Currently amended) A method of receiving a heartbeat signal in a cluster computing system, the method comprising:

selectively receiving a heartbeat signal in a remote host group ~~by use of a network with the remote host group or by use of a remote link coupled with a storage system associated with the remote host group.~~

7. (Currently amended) An electronically-readable medium storing a program for permitting a computer to perform a method of receiving a heartbeat signal in a cluster computing system, the method comprising:

selectively receiving a heartbeat signal in a remote host group ~~by use of a network with the remote host group or by use of a remote link coupled with a storage system associated with the remote host group.~~

8. (Currently amended) A program code embedded on a carrier wave for causing a computer to perform a method of receiving a heartbeat signal in a cluster computing system, the method comprising:

selectively receiving a heartbeat signal in a remote host group ~~by use of a network with the remote host group or~~ by use of a remote link coupled with a storage system associated with the remote host group.

9. (Currently amended) A cluster computing system, comprising:

a production host group;

a standby host group coupled to the production host group by a network; and

a remote mirror coupled between the production host group and the standby host group;

the production host group configured to selectively send a heartbeat signal to the standby host group by use of ~~at least one of the network and~~ the remote mirror.

10. (Currently amended) A method of checking for failure in a cluster computing system, the method comprising:

generating a heartbeat signal from a first host group;

selectively sending the heartbeat signal from the first host group to a second to host group by use of ~~a network coupled between the host groups or~~ a remote mirror coupled between the host groups.

11. (Currently amended) A cluster computing system, comprising:

a production host group;

a standby host group coupled to the production host group by a network; and

a remote mirror coupled between the production host group and the standby host group, the remote mirror including a production site heartbeat storage volume (heartbeat PVOL) and a standby site heartbeat storage volume (heartbeat SVOL) coupled by a remote link to the heartbeat PVOL;

the production host group configured to selectively send a heartbeat signal to the standby host group by use of ~~at least one of the network and~~ the remote link.

12. (Original) The cluster computing system of claim 11 wherein the production host group comprises a first heartbeat check module configured to generate the heartbeat signal.

13. (Original) The cluster computing system of claim 11 wherein the standby host group comprises a second heartbeat check module configured to receive the heartbeat signal.

14. (Original) The cluster computing system of claim 11 wherein the standby host group manages operations of the cluster computing system if an invalid heartbeat signal is received by the standby host group from the production host group.

15. (Original) The cluster computing system of claim 11 wherein the heartbeat message comprises: a serial number assigned to the heartbeat message, a time indicator indicating a time of the generation of the heartbeat message, and an identifier identifying a sender of the heartbeat message.

a 16. (Currently amended) The cluster computing system of claim 11 further comprising:
a second remote mirror coupled between the production host group and the standby host group, the second remote mirror including a second remote link for transmitting a heartbeat signal;

the standby host group configured to selectively send a heartbeat signal to the production host group by use of ~~at least one of the network and~~ the second remote link.

17. (Currently amended) A method of checking for failure in a cluster computing system, the method comprising:

generating a heartbeat signal from a production host group;
selectively sending the heartbeat signal to the standby host group from the production host group by use of ~~at least one of a network and~~ a remote link; and

enabling the standby host group to manage operations of the cluster computing system if an invalid heartbeat signal is received by the standby host group from the production host group.

18. (Currently amended) The method of claim 17 further comprising:
selectively sending a heartbeat signal to the production host group from the standby host group by use of ~~at least one of a network and~~ a second remote link.

19. (Original) The method of claim 17 further comprising:
installing remote mirrors in the cluster computing system, including:
registering a first storage volume to a device address entry, the first storage volume located in a production site, and, from the production site, changing a remote mirror that includes the first storage volume into an enabled mode;
sending an activation message from the production site to a standby site;
registering a second storage volume to the device address entry, the second storage volume located in the standby site; and
from the standby site, changing the remote mirror into an enabled mode to install a remote mirror formed by the first storage volume and second storage volume.

20. (Original) The method of claim 17 further comprising:
de-installing remote mirrors in the cluster computing system, including:
from a production site, changing a remote mirror into a disabled mode;
sending a de-activation message from the first production site to a standby site; and
from the standby site, changing the remote mirror into a disabled mode to de-install the remote mirror.

21. (Original) The method of claim 17 wherein the selectively sending step comprises:
determining if a network between the production site host and the standby site host is enabled;
if the network is enabled, sending a heartbeat message along the network from the production site host to the standby site host;
determining if a remote mirror between the production site host and the standby site host is enabled; and
if the remote mirror is enabled, sending a heartbeat message along the remote mirror from the production site host to the standby site host.

22. (Original) The method of claim 17 further comprising:

receiving a heartbeat message from the production site host to the standby site host in the cluster computing system, including:

determining if a network between the production site host and the standby site host is enabled;

if the network is enabled, checking for a heartbeat message along the network from the production site host to the standby site host;

determining if a remote mirror between the production site host and the standby site host is enabled;

if the remote mirror is enabled, checking for a heartbeat message along the remote mirror from the production site host to the standby site host; and

if an invalid heartbeat is received along the network and along the remote mirror, enabling the standby host to manage operations of the cluster computing system.

23. (Original) A method of setting a heartbeat checking procedure between a primary group and a secondary group in a cluster computing system, the method comprising:

providing a request command that determines the heartbeat checking procedure;

responsive to the request command, enabling a first heartbeat check module in the primary group to activate or de-activate a network between the primary group and the secondary group;

responsive to the request command, enabling the first heartbeat check module to activate or de-activate a remote mirror between the primary group and the secondary group;

permitting the first heartbeat check module to send the request command to a second heartbeat check module in the secondary group;

responsive to the request command, enabling the second heartbeat check module to activate or de-activate the network between the primary group and the secondary group;

responsive to the request command, enabling the second heartbeat check module to activate or de-activate the remote mirror between the primary group and the secondary group;

if the second heartbeat check module has activated the network, then checking for a heartbeat signal along the network; and

if the second heartbeat check module has activated the remote mirror, then checking for a heartbeat signal along the remote mirror.

24. (Original) A method of failure notification in a cluster computing system, the method comprising:

selectively activating a network between a primary group and a secondary group;

selectively activating a remote mirror between the primary group and the secondary group;

checking for a failure occurrence in the primary group;

if the network is activated, then sending a failure notification message from the primary group to the secondary group along the network;

if the remote mirror is activated, then sending a failure notification message from the primary group to the secondary group along the remote mirror; and

based upon the failure notification message, displaying in the secondary group an indication of the failure occurrence.
